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5      **STABLE, LOW FREE FORMALDEHYDE, SYNERGISTIC ANTIMICROBIAL**  
**COMPOSITIONS OF ALDEHYDE DONORS AND DEHYDROACETIC ACID**

This application claims the priority of U.S. Provisional Application No.

60/405,036, filed on August 20, 2002 which is hereby incorporated hereby by reference in its

10    entirety.

**Field of the Invention**

The present invention relates to stable, low free formaldehyde, synergistic antimicrobial mixtures of a first component including one or more aldehyde donor, a second  
15    component including a stabilizer; and a third component including dehydroacetic acid or salt thereof.

**Background of the Invention**

The need for effective and economical preservative compositions is well known.

20    Many products require the addition of a preservative to protect against contamination and

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growth of microbes. Examples of such products include personal care products such as shampoos, creams, lotions, cosmetics, and soaps; household products such as laundry detergents, hard surface cleaners, fabric softeners, and various industrial products; such as paint, wood, textiles, adhesives, sealants, leather, rope, paper pulp, plastics, fuel, oil, and rubber and metal working fluids. The control of slime-producing bacterial and fungi in pulp and paper mills and in cooling towers is also a matter of substantial commercial importance.

In particular, personal care product compositions provide a nutrient-rich media which benefit from the incorporation of preservatives to control the growth of microorganisms and to prevent spoilage. Generally, the shelf life of these products depends on the resistance to microbial spoilage of components contained therein. It is therefore desirable to formulate a preservative which controls microbial contamination in personal care products, household products, and industrial products.

Formaldehyde derivatives are known preservatives. For example, U.S. Patent No. 3,987,184 discloses 1,3-dimethylol-5,5-dimethylhydantoin (DMDMH) useful as a formaldehyde donor compound for the preservation of personal care products, cosmetics, and household and industrial products. U.S. Patent No. 5,405,862 teaches a formaldehyde donor composition containing dimethyloldimethylhydantoin, monomethyloldimethylhydantoin, and dimethylhydantoin having less than 0.1% by weight of free formaldehyde based upon 100% of total composition, useful in biocidal effective amounts in industrial or personal care products. U.S. Patent No. 6,143,204 discloses a broad spectrum preservative composition having a dialkanol-substituted dimethyl hydantoin, an iodopropynyl compound, a stabilizer of hydantoin, and a hydroxyl solvent. U.S. Patent No. 6,121,302 teaches a broad spectrum



## Summary of the Invention

In accordance with the invention, it has now been discovered that a stable, low free formaldehyde, synergistic antimicrobial combination of a first component including one or more aldehyde donor, a second component including a stabilizer; and a third component including dehydroacetic acid or salt thereof, gives both broad spectrum bactericidal and fungicidal activity suitable for use in personal care products, household products, and various industrial products and systems. Preferably, the first component includes one or more alkanol-substituted dimethylhydantoin, and the second component includes a stabilizer of dimethylhydantoin. Particular advantages of the antimicrobial composition of the invention are the low amounts of free formaldehyde, i.e., less than 0.2%.

By combining these components in products which require protection against microbial attack, an antimicrobial composition which completely controls microbiological contamination is obtained. Furthermore, due to the synergistic effect of the components, much less active material of each component is required as opposed to when each component is used alone. Another advantage of the synergistic antimicrobial composition is that it is able to fully control a broader spectrum of bacteria and fungi than any of the individual components. A further advantage is that the antimicrobial composition requires no iodine which at high levels is considered toxic. Accordingly, this antimicrobial composition is economical, requiring lesser amounts of expensive components, easy to use, and less likely to have toxic or skin sensitizing effects on individuals exposed to the product.

A particularly advantageous aspect of the invention is that a small amount of dehydroxyacetic acid (DHA) in combination with one or more aldehyde donor, and a stabilizer

such as dimethyl hydantoin forms a stable composition. This activity could in no way be predicted based on the known reaction of dehydroacetic acid sodium salt with formaldehyde released from aldehyde donors in aqueous solution. The interaction and declining levels of dehydroacetic acid sodium salt was shown by NMR analysis in literature in the Journal of Society of Cosmetic Chemists, entitled "Dehydroacetic acid sodium salt stability in cosmetic preservative mixtures," by C.A. Bennassi, et al., Vol. 10, pp. 29-37 (1988). This reaction forms an unstable composition, decreasing levels of DHA, thereby eliminating the fungicidal and bactericidal effect of DHA. Inclusion of a stabilizer such as dimethyl hydantoin serves to minimize the amount of free formaldehyde, thus eliminating the reaction of free formaldehyde with DHA.

Another advantage is that the antimicrobial composition of the invention remains stable and does not freeze at temperatures as low as -15° C. The more solids there are in a mixture, the more likely that the freezing point of the mixture will be increased. A typical hydantoin, and a typical hydantoin in combination with a dehydroxyacetic acid or salt thereof, freezes at -15° C. Therefore, it would be likely that the antimicrobial composition, containing more solids than a typical hydantoin or typical hydantoin in combination with DHA, would freeze at -15° C. However, the antimicrobial composition does not freeze or form crystals at -15° C; thus, this activity could in no way be predicted as a typical hydantoin, and a typical hydantoin in combination with a dehydroacetic acid or salt thereof forms crystals at -15° C.

The antimicrobial composition may be used in personal care products such as shampoos, conditioners, rinses, creams, lotions, dental care products such as mouthwash, toothpaste, spray, and denture cleaners or soaks, baby wipes and other woven and non-woven

wipes; household products such as detergents, hard surface cleaners, fabric softeners, and the like; and industrial products such as paint, wood, wood treatment, paper board, sheet rock, paper pulp, ceiling tiles, textiles, adhesives, sealants, leather, rope, plastics, petroleum, fuel, oil, and rubber and metal working fluids; or industrial systems such as pulp and papermaking processing, water treatment systems, cooling water, swimming pools and spas, decorative fountains, membranes, brewery pastures, toilet and urinal applications, food and beverage sanitation, sporicidal formulations, sterilization of clinical products and surgical instruments, and preservation including clay slurry and starch. The antimicrobial composition can be added to the aforementioned products or systems already formulated or the three components can be added to the products or systems separately.

The components of the synergistic antimicrobial composition are easy to formulate and may be added to an article or system to be treated as separate entities, or as a combination. The components are physically and chemically compatible and may be combined with carriers and excipients.

Methods for inhibiting the growth of or reducing microorganisms in personal care, household, or industrial products or systems are also provided by this invention.

Personal care products, household products, and industrial products comprising the antimicrobial composition are further provided by this invention.

## Detailed Description of the Invention

As used herein, the phrases “antimicrobial,” “biocidal,” and “inhibiting microbial growth” describe the killing of, as well as the inhibition of, or control of, the growth of bacteria, yeasts, fungi, and algae.

As used herein, the phrase "microbiological contamination" describes contamination against microbes including bacteria, yeasts, fungi, and algae.

An “antimicrobial effective amount” is an amount effective to inhibit the growth of and/or kill microorganisms.

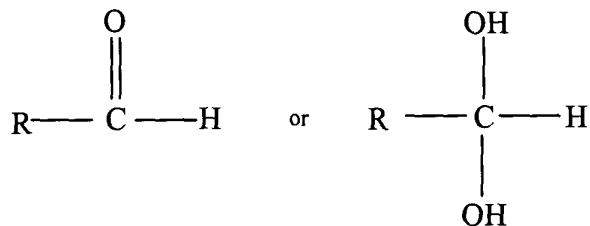
10 The first component of the antimicrobial composition includes one or more aldehyde donor.

### Aldehyde and Aldehyde Donor

The term “aldehyde” refers to any compound that has an aldehyde group, especially those aldehydes that exhibit antimicrobial activity, such as formaldehyde, orthophthalaldehyde, cinnamaldehyde, and mixtures thereof.

15           The term “aldehyde donor” as used herein is defined as any material which is not an aldehyde but upon aqueous dilution liberates a compound which gives positive reactions with aldehyde identifying reagents, i.e., a compound which can identify aldehyde groups.

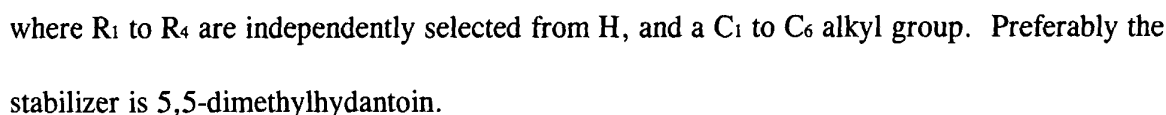
Generally the liberated compound has the formula:











The third component includes dehydroacetic acid or its salts thereof; for example, dehydroacetic acid sodium salt.

Water is the preferred solvent for use in the present invention. Optionally, a solvent can be used which includes mono-, di-, and polyhydroxyl alcohols. For polyhydroxyl alcohols having from about 1 to 5 carbon atoms, most preferably propanol, may be used. Dihydroxyl alcohols (e.g., glycols) such as C<sub>2</sub> to C<sub>8</sub> dihydroxyl alcohols (e.g., ethylene glycol and butylene glycol) are advantageous. Other compounds which can be used include tripropylene glycol, glycerin, diglycerin, PPG-9, PPG02-buteth-2, PPG-1, butoxydiglycol, PPG-2 butyl ether, glycereth-7, sorbitol, isopentyldiol, and phenoxy ethanol.

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workplace exposure risk to formaldehyde resulting in greater safety and reduced regulatory issues.

Table 1 provides ranges for the broad spectrum synergistic antimicrobial composition concentrates of the invention.

Broad Spectrum Synergistic Antimicrobial Composition Concentrates		
	Broad wt. % range	Preferred wt. % range
aldehyde donor	5-95	50-75
stabilizer	0-30	5-20
DHA	0.5-95	2-30

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The ratio of the aldehyde donor to DHA or salt thereof for the broad spectrum concentrate may broadly be from about 1:100 to 100:1, preferably from about 1:60 to 60:1, and more preferably from 0.05:30 to 30:0.05 and the ratio of stabilizer, such as dimethyl hydantoin, to aldehyde donor sufficient to minimize the amount of free formaldehyde, thus reducing or preventing the reaction of free formaldehyde with DHA.

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The preservative concentrates of the invention can be readily prepared in accordance with procedures well known to those skilled in the art, simply by mixing the components set forth in Table 1, supra, and adjusting the pH using any organic or mineral acid (e.g., hydrochloric acid and acetic acid) suitable for the user's purpose. The manner in which the components are mixed can be modified to suit the needs of the formulator, as discussed below, without departing from the spirit of the invention.

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The concentration of the active compounds in the use dilution depends on the nature of the microorganisms to be combated and the composition of the final product to be preserved. For example, the optimum amount of antimicrobial composition to use for preserving an aqueous composition can be determined by means of screening tests known in the art, and in accordance with the formulation ranges provided in Table 1. When preserving an aqueous composition, the use level is generally 0.00005 % (0.5 ppm) to 5 % (50,000 ppm) by weight, preferably from about 0.01 % (100 ppm) to 1 % (10,000 ppm) of the final composition. Preservative formulations of the invention can also be used directly as they are manufactured without dilution, or in any other manner traditionally used in manufacturing, such as by metering.

Antimicrobial compositions of this invention may be used directly as they are manufactured, without dilution. They may be poured into small batches (from one to thousands of pounds) of product at any point in its manufacture. Also, the antimicrobial compositions may be pumped into medium sized batches (from thousands to tens of thousands of pounds).

The antimicrobial composition of the invention may also be metered continuously from a storage tank into large sized production runs (from tens of thousands to millions of pounds) in systems custom-designed to continuously mix all the components of the finished product at approximately the same rate that it is filled into its final package. The blending elements of continuous mixers are mostly shaped in the form of spirals or screws, effecting on rotation both a mixing and a transport of the product composition.











Table 4

Synergy at Day 14

<u>Sample</u>	<u>Q<sub>A</sub></u>	<u>Q<sub>B</sub></u>	<u>Q<sub>a</sub></u>	<u>Q<sub>b</sub></u>	$\frac{Q_A}{Q_a} + \frac{Q_B}{Q_b}$	$\frac{< 1 =}{\text{Synergy}}$
0.05 % Glydant 2000®			0.05 % Glydant 2000®			
0.2 % DHA				0.2 % DHA		
0.025 % Glydant 2000® + 0.075 % DHA	0.025 %	0.075 %			$\frac{0.025}{0.05} + \frac{0.075}{0.2}$	$0.5 + 0.37$ $= 0.87$ Synergy

Thus, the antimicrobial composition described herein provides a method for

5 inhibiting the growth of or reducing microorganisms such as bacteria and fungi in a wide variety of compositions, i.e., personal care products, household products, and industrial products and systems. The antimicrobial composition eliminates the need for iodine, while at the same time utilizing ultra-low free formaldehyde compositions in combination with DHA or DHA.Na which is fungicidal and bactericidal.

10 All patents, applications, articles, publications, and test methods mentioned above are hereby incorporated by reference.

Many variations of the present invention will suggest themselves to those skilled in the art in light of the above detailed description. Such obvious variations are within the full intended scope of the appended claims.